where and are outside the scope of this note.

During one such observations I saw a female of the genus *Poltys* C.L. Koch being taken. This is very rare genus in India and is being reported for the first time from Pune.

The specimen collected by the wasp is an immature female. The morphological characters of this specimen do not tally with the known species either in description or in the illustration referred to in FAUNA OF INDIA, spiders (Araneae : Araneidae) 1982 pg. 166-179. Fig 1 shows the morphological characters for the specimen in. This note records the occurrence of the genus *Poltys* C.L. Koch in Pune, Maharashtra, and extends its distribution to western India.

January 3, 1989. D. BASTAWADE

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36. FLOWER-VISITORS AND POLLINATION OF *ADHATODA ZEYLANICA* (ACANTHACEAE)

(*With a text-figure*)

Plant-animal interactions, particularly at the flower level, are related to the structure, organisation and continued functioning of the respective communities (Heithaus 1974, Frankie 1976, Moldenke 1975, 1979). The need to understand such interactions, especially in the species-rich tropical ecosystems, is essential. This paper describes the interaction of 13 insect species with the flowers of *Adhatoda zeylanica* Medicus (Acanthaceae), a large tropical shrub and an important medicinal plant.

The plants flower at Vishakapatnam (17°42' N, 82°18' E) every year from mid January to early April. Flowers are borne in the axils of leafy bracts on a pedunculate spike inflorescence 5-9 cm long. They are zygomorphic, the corolla base forming a short tube

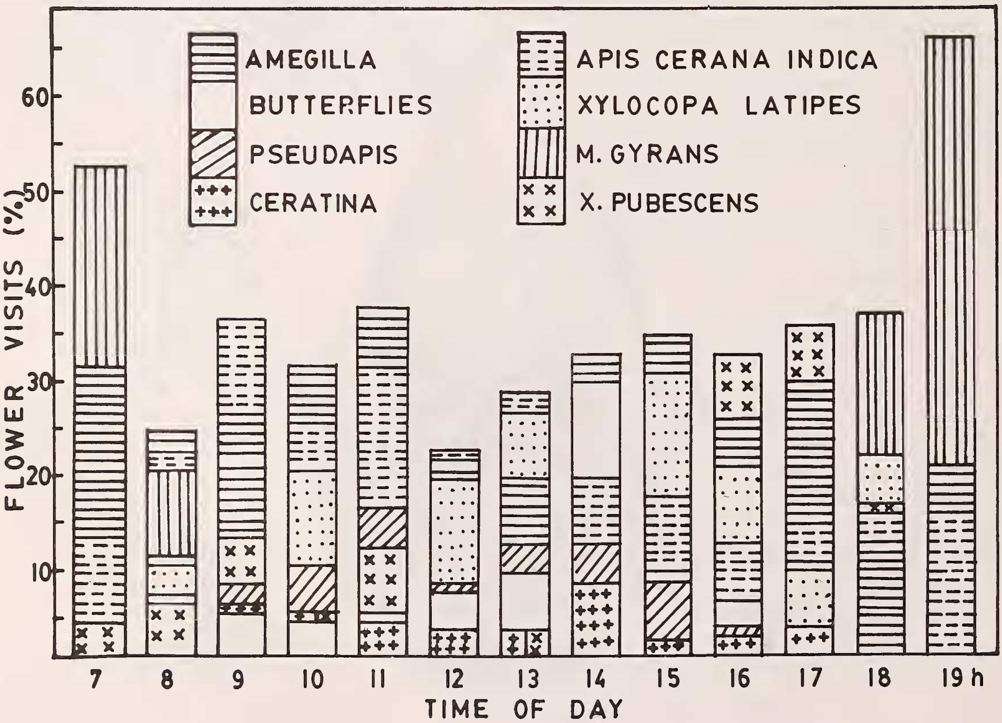

Fig. 1. Diurnal periodicity in foraging activity of different flower – visitors on *A. zeylanica*.

TABLE 1
FLOWER-VISITORS OF *A. zeylanica:* FORAGE TYPE AND VISITATION RATES IN

Insect Species	Forage Type		Flowering Phase					
	Nectar	Pollen	Initial (%) 27 Jan 86		Peak (%) 17 Feb 86		Final (%) 22 March 86	
HYMENOPTERA								
Bees								
Apis cerana indica	+	+	445	(33)	654	(20)	443	(28)
Trigona sp.	—	+	65	(5)	78	(2)	74	(5)
Xylocopa pubescens	+		0		361	(11)	41	(3)
Xylocopa latipes	+	—	0		409	(13)	102	(6)
Pseudapis oxybeloides	—	+	138	(10)	182	(6)	156	(10)
Ceratina sp.	—	+	92	(7)	106	(3)	115	(7)
Amegilla sp.	+	+	600	(45)	788	(25)	564	(32)
Pithitis binghami	—	+	0		47	(1.5)	0	
Wasps								
Delta conedus	+	—	0		12	(0.5)	0	
Scolia sp.	+	—	0		31	(1)	0	
LEPIDOPTERA								
Moths								
Macroglassum gyrans	+	—	0		348	(11)	0	
Butterflies								
Euploea core	+	—	0		72	(2)	27	(2)
Pelopidas mathias	+	—	0		122	(4)	45	(3)
Total visits			1340		3210		1567	

and the upper part becoming two-lipped and galeate. The outer three petals are imbricate; the opposite two are united, their facial margins forming a narrow groove through which passes the filiform style with its linear stigma. The two epipetalous stamens with the introrse anthers are inserted in the corolla over the most part of their length and are placed, together with the style, adjacent to and covered by the upper hooded corolla lobe. The style projects slightly beyond the stigma, thereby precluding contact with anthers when they dehisce.

Daily anthesis of flowers takes place in the period from 0730- 1830 hrs., a large number of flowers anthesing before 1100 hrs. Anthers dehisce shortly after anthesis, exposing the pollen, which is then visible to the naked eye as a white powdery mass. Pollen grains are large in size (65 x 45 microns), their number per anther averages 17800. Nectar secretion also begins with the anthesis, but in traces, and continues till the flower drops off after 48 hrs. of anthesis. Hand refractometer readings showed that the sugar concentration ranges from 17–22%. Paper chromatographic analysis revealed the sugars sucrose, glucose and fructose, the first dominating. Amino acids and proteins are present, as indicated by Ninhydrine and Bromo-phenol tests respectively.

In the flowering season of 1986, in all 13 insect species, 10 belonging to hymenoptra and 3 to lepidoptera, were found foraging at the flowers of *A. zeylanica* (Table 1). The visits of *Amegilla* sp., *Trigona* sp., *Ceratina* sp., *Pithitis* sp., and *Pseudapis* sp., among the hymenoptera were directed to pollen collection only. The other hymenoptera and the lepidoptera confined their visits to nectar foraging. The 13 species could only be recorded in the peak flowering phase, while in the other phases some of them did not appear. In all the three phases, *Amegilla* and *Apis c. indica* made a larger number of visits than other species. At the peak phase of flowering, besides these two species, *Xylocopa* and *Macroglossum* also shared a sizeable proportion of the total visits. The absence of *Xylocopa* in the initial phase could be understood because, in that period, it mostly concentrated on *Gliricidia sepium* (Jacq.) Kunth ex Walp. with a mass bloom.

All the 13 flower-visitors are diurnal in their activity. They visited the flowers during 0630-1900 hrs. The first to visit the flowers was *M. gyrans*. It foraged at the flowers for 2 hours in the morning and also for 2 hours in the evening, when other visitors were not that active. This type of stratified foraging behaviour probably is a strategy to avoid competition with other foragers. *Amegilla* and

Apis were active all through from 0630-1900 hrs. The activity of *Pseudapis* started late in the morning and ceased early in the evening, as also that of *Ceratina* and butterflies. Both the species of *Xylocopa* began their activity slightly later in the morning and finished it a little earlier in the evening (Fig. 1).

It is not possible to relate the activity of the various foragers to the weather parameters. It is assumed that the availability of forage might determine the visitation rates. Accordingly, in the period before 1100 hrs. there was a tendency to greater activity because a larger number of flowers open at that time. Although *M. gyrans* appeared to confine its activity to a cooler part of the day, observations of its activity on other plant species in the same biotope did not provide any support for such a behavioural pattern.

Data regarding the number of flowers visited per minute and the time spent on a flower by eight of the more common visitors indicated that *M. gyrans* was more mobile, covering on the average 57 flowers per minute and spending on the average 2 seconds per flower; the corresponding figures for others are *Trigona* 13.5 and 4.5; *Pseudapis* 12 and 4; *A.c. indica* 7.5 and 8.5; *Ceratina* 11 and 5.5; *Amegilla* 8 and 8.5.; *X. latipes* 6 and 12; *X. pubescens* 5 and 11.5.

Controlled experiments revealed the total absence of apomixis and spontaneous or direct autogamy. The 20 flowers tested for indirect autogamy yielded 50% fruit set with seeds set 100% and fecundity 50%. Those tested for geitonogamy yielded 75% fruit set, 100% seed set and 75% fecundity. Those for xenogamy gave 90% fruit set, 100% seed set and 90% fecundity. A close examination of the intrafloral behaviour of the 13 visitors revealed that only the carpenter bees (*Xylocopa* spp.) made meaningful contacts with the essential flower parts while foraging (Fig. 2), and vectored the pollen. The stamens and style, being placed adjacent to the upper lobe, brushed against the upper side of the visitor, thereby depositing or receiving pollen nototribically.

When the carpenter bee probes the flower for nectar, its body size fits exactly into the gap between the two corolla lobes. The zygomorphic nature of the flowers with the essential parts placed towards the upper lip is a precise adaptation for nototribic pollination by such large-bodied insects as *Xylocopa* (Proctor & Yeo 1972). The role of this bee in vectoring pollen was verified by examining the stigmas for pollen after the flowers were visited by different visitors. Only those stigmas visited by *Xylocopa* revealed pollen, thereby confirming the exclusive role of *Xylocopa* in pollination.

The pollinations that result from *Xylocopa* visitation of *A. zeylanica* flowers might be either auto-, geitono- or xeno-gamous. However, it was found that both the species of *Xylocopa* visited a few flowers in a foray and then flew away. This type of behaviour of the forager, together with the behaviour of the plant producing a small number of flowers per day and with minimal quantities of nectar, promote xenogamy which is a superior mode of reproduction in *A. zeylanica* (Faegri & Pijl 1979, Cruden 1976).

The visitors other than *Xylocopa* utilised the floral resource, but did not render pollination service. However, their interaction with the flowers assumes significance if it is treated from the ecosystem point of view. The visitors may be the essential pollinators of some other species in the same biotope which may bloom outside the season of *A. zeylanica*. It is important that they be maintained in the ecosystem until the right plants that require them for pollinatory service come into bloom (Baker *et al.* 1971).

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